A MANUAL OF USEFUL DATA

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(SECOND PRINTING)

Additional copies of this Manual may be secured by request to:

WABASH DRILLING COMPANY,
7649 Delmar Boulevard
St. Louis 30, Missouri

FOREWORD

It was in 1896 that a foundation specialist named Elliott moved to St. Louis and established the John E. Elliott Contracting Company, later re-named Wabash Drilling Company. Their first jobs were on important downtown buildings of that day, some of which are still in use. As time passed, both the scope and area of operations widened, until today Wabash Drilling Company serves not only the St. Louis area, but sends their rigs over the eastern half of the United States.

Wabash has always pioneered in equipment and methods, and through the development of machinery of advanced design, has brought new efficiency and economy to foundation work. Collateral with the development of Wabash drilled cast-in-place piling, Wabash has added other services, such as soil testing, test-loading, cutting openings in structural materials, drilling in difficult situations, etc. A complete catalog of Wabash services is available on request, as is the advice of Wabash experts in site investigation and geotechnical processes.

As another service to their friends and customers, Wabash Drilling Company makes available this "Manual of Useful Information."

UNITS OF MEASURE

LINEAR MEASURE

U. S. System

12 Inches	=	1 Foot
3 Feet (36 Inches)	=	1 Yard
16½ Feet 5½ Yards	=	1 Rod
40 Rods 660 Feet	=	1 Furlong
5280 Feet 1760 Yards 8 Furlongs	=	1 Mile

Metric System

10 Millimeters	=	1 Centimeter
10 Centimeters	=	1 Decimeter
10 Decimeters	=	1 Meter
10 Meters	=	1 Decameter
10 Decameters	=	1 Hectometer
10 Hectometers	=	1 Kilometer

Linear Conversions — U. S. to Metric

1 Inch	=	2.54 Centimeters
1 Foot	=	30.48 Centimeters
1 Yard	=	.9144 Meters
1 Mile	=	1.609 Kilometers

Metric to U. S.

1 Meter	=	3.281 Feet 39.37 Inches
1 Meter	=	1.094 Yards
1 Kilometer	=	3281 Feet 1094 Yards

UNITS OF MEASURE

SQUARE AND LAND MEASURE

U. S. System

144 Square Inches	=	1 Square Foot
9 Square Feet	=	1 Square Yard
30¼ Square Yards	=	1 Square Rod
43560 Square Feet 4840 Square Yards 160 Square Rods	=	1 Acre
640 Acres	=	1 Square Mile

Metric System

100 Square Millimeters	=	1 Square Centimeter
100 Square Centimeters	=	1 Square Decimeter
100 Square Decimeters	=	1 Square Meter
100 Square Meters	=	1 Are
100 Ares	=	1 Hectare
100 Hectares	=	1 Square Kilometer

Square Conversion — U. S. to Metric

1 Square Inch	=	6.45 Square Centimeters
1 Square Foot	=	.093 Square Meters
1 Square Yard	=	.836 Square Meters
1 Square Mile	=	2.59 Square Kilometers

UNITS OF MEASURE

VOLUME MEASURE

U. S. System

1728 Cubic Inches .03704 Cubic Yards 7.48 Gallons	= 1 Cubic Foot
27 Cubic Feet 202 Gallons	= 1 Cubic Yard
128 Cubic Feet	= 1 Cord
24¾ Cubic Feet	= 1 Perch
144 Cubic Inches of Wood 12″ x 12″ x 1″)	= 1 Board Foot
1 Cub. Ft. (94 lbs. Cement)	= 1 Bag or Sack of Cement
4 Bags of Cement	= 1 Barrel of Cement

U. S. System — Liquid Measure

4 Gills	= 1 Pint
2 Pints 57.75 Cubic Inches	= 1 Quart
4 Quarts .134 Cubic Feet 8.345 Pounds of Water	= 1 Gallon
31½ Gallons	= 1 Barrel
2 Barrels 63 Gallons	= 1 Hogshead
62.42 Pounds of Water	= 1 Cu. Ft.

U. S. System — Dry Measure

2 Pints	= 1 Quart
8 Quarts	= 1 Peck
4 Pecks	= 1 Bushel

UNITS OF MEASURE

VOLUME MEASURE (Cont.)

Metric System

1000 Cubic Millimeters = 1 Cubic Centimeter

1000 Cubic Centimeters, 1 Kilogram Pure Water at 4° C = 1 Cubic Decimeter, 1 Liter

1000 Cubic Decimeters = 1 Cubic Meter

Volume Conversion — U. S. to Metric

1 Cubic Foot = .0283 Cubic Meters

1 Cubic Yard = .765 Cubic Meters

1 Gallon = 3.785 Liters

Weights — U. S. Commercial
U. S. System (Avoirdupois)

437½ Grains = 1 Ounce

16 Ounces = 1 Pound

100 Pounds = 1 Hundredweight

1000 Pounds = 1 Kip

2000 Pounds, 2 Kips = 1 Ton

Metric System

10 Milligrams = 1 Centigram

10 Centigrams = 1 Decigram

10 Decigrams = 1 Gram

10 Grams = 1 Dekagram

10 Dekagrams = 1 Hectogram

10 Hectograms = 1 Kilogram or Kilo

1000 Kilograms = 1 Metric Ton

UNITS OF MEASURE

Angular Measure

60 Seconds (″) = 1 Minute (′)
60 Minutes (′) = 1 Degree (°)
57.30 Degrees = 1 Radian
90 Degrees = 1 Right Angle or Quadrant
180 Degrees = Pi (π) Radians
360 Degrees = 1 Circle = 4 Quadrants = 2 π Radians

Surveyor's Linear Measure

7.92 Inches = 1 Link
25 Links, 16.5 Feet = 1 Rod
4 Rods, 100 Links, 66 Feet = 1 Chain
80 Chains = 1 Mile

Decimal Equivalents

	16 ths	32 nds	64 ths	
			1	.01562
		1		.03125
			3	.04688
	1			.0625
			5	.07812
		3		.09375
			7	.10938
1/8				.125
			9	.14062
		5		.15625
			11	.17188
	3			.1875
			13	.20312
		7		.21875
			15	.23438
1/4				.25
			17	.26562
		9		.28125
			19	.29688
	5			.3125
			21	.32812
		11		.34375
			23	.35938
3/8				.375
			25	.39062
		13		.40625
			27	.42188
	7			.4375
			29	.45312
		15		.46875
			31	.48438
1/2				.5

	16 ths	32 nds	64 ths	
			33	.51562
		17		.53125
			35	.54688
	9			.5625
			37	.57812
		19		.59375
			39	.60938
5/8				.625
			41	.64062
		21		.65625
			43	.67188
	11			.6875
			45	.70312
		23		.71875
			47	.73438
3/4				.75
			49	.76562
		25		.78125
			51	.79688
	13			.8125
			53	.82812
		27		.84375
			55	.85938
7/8				.875
			57	.89062
		29		.90625
			59	.92188
	15			.9375
			61	.95312
		31		.96875
			63	.98438
1				1.0

UNITS OF MEASURE

Surveyor's Square Measure

625 Square Links = 1 Square Rod
16 Square Rods = 1 Square Chain
10 Square Chains = 1 Acre = $(208.71')^2$
640 Acres = 1 Square Mile = 1 Section
36 Square Miles = 36 Sections = $(6 \text{ Miles})^2$ (Approx.) = 1 Township

MISCELLANEOUS

Temperature (° F) = $^9/_5$ Temp (° C) + 32° F
Temperature (° C) = $^5/_9$ (° F − 32°)
Absolute Zero = −273.13° C or −459.4° F
1 Atmosphere = 29.92 Inches of Mercury = 33.90 Feet of Water or Pressure of 14.70 Lbs./Sq. In.
1 British Therm. Unit = 777.5 Foot Pounds
1 Horse Power = 33,000 Foot Pounds/Min.
1 Watt = 44.24 Foot Pounds/Min.
1 Kilowatt = 1000 Watts
1 Foot Per Second = 0.6818 Mile Per Hour
88 Feet Per Second = 60 Miles Per Hour
1 Kilometer Per Hour = .6214 Mile Per Hour
6 Feet = 1 Fathom
1 Nautical Mile = 1.1516 Statute Mile (6080.204 Ft.) = 1 Minute of Arc on the Earth's Surface at the Equator
1 Statute Mile = .8684 Nautical Mile or 5280 Ft.

BUILDING MATERIALS

WEIGHTS OF MATERIAL

Substance	Weight, Pounds per Cubic Foot
ASHLAR MASONRY	
Granite, syenite, gneiss	165
Limestone, marble	160
Sandstone, bluestone	140
MORTAR RUBBLE MASONRY	
Granite, syenite, gneiss	155
Limestone, marble	150
Sandstone, bluestone	130
DRY RUBBLE MASONRY	
Granite, syenite, gneiss	130
Limestone, marble	125
Sandstone, bluestone	110
BRICK MASONRY	
Pressed Brick	140
Common Brick	120
Soft Brick	100
CONCRETE MASONRY	
Cement, stone, sand	144
Cement, slag, etc.	130
Cement, cinder, etc.	100

WEIGHTS OF MATERIAL (Cont.)

Substance	Weight, Pounds per Cubic Foot
VARIOUS BUILDING MATERIALS	
Ashes, cinders	40–45
Cement, Portland, loose	90
Cement, Portland, set	183
Lime, gypsum, loose	53–64
Mortar, set	103
Slags, bank slag	67–72
Slags, bank screenings	98–117
Slags, machine slag	96
Slags, slag sand	49–55
EARTH, ETC., EXCAVATED	
Clay, dry	63
Clay, damp, plastic	110
Clay and gravel, dry	100
Earth, dry, loose	76
Earth, dry, packed	95
Earth, moist, loose	78
Earth, moist, packed	96
Earth, mud, flowing	108
Earth, mud, packed	115
Riprap, limestone	80–115
Riprap, sandstone	90
Riprap, shale	105
Sand, gravel, dry, loose	90–105
Sand, gravel, dry, packed	100–120
Sand, gravel, dry, wet	118–120

WEIGHTS OF MATERIAL (Cont.)

Substance	Weight, Pounds per Cubic Foot
EXCAVATION IN WATER	
Sand or gravel	60
Sand or gravel and clay	65
Clay	80
River mud	90
Soil	70
Stone riprap	65
MISCELLANEOUS	
Alcohol, 100%	49
Coal, anthracite	97
Coal, bituminous	84
Coal, coke	75
Cotton, Flax, Hemp	93
Glass, common	156
Iron, cast, pig	450
Iron, steel	490
Lead	710
Paper	58
Petroleum	54
Petroleum gasoline	42
Pitch	69
Tar, bituminous	75
Tin, cast-hammered	459
Water, 4° C, max. density	62.426
Water, snow, fresh fallen	8
Wool	82

WEIGHTS OF FLOORS, CEILINGS, AND ROOFS, IN POUNDS PER SQUARE FOOT

	Weight (psf)
FLOORINGS:—	
Cement finish, per inch of thickness	12
Cinder concrete fill, per inch of thickness	8
3″ creosoted wood blocks on ½″ mortar base	21
2″ creosoted wood blocks on ½″ mortar base	17
3″ creosoted wood blocks on ⅛″ mastic bed	12
2″ creosoted wood blocks on ⅛″ mastic bed	9
⅞″ hardwood floor on sleepers clipped to concrete without fill	5
1½″ terrazzo floor finish directly on slab	19
1½″ terrazzo floor finish on 1″ mortar bed	30
¾″ ceramic or quarry tile on ½″ mortar bed	16
¾″ ceramic or quarry tile on 1″ mortar bed	22
¼″ linoleum or asphalt tile directly on concrete	1
¼″ linoleum or asphalt tile on 1″ mortar bed	12
¾″ mastic floor	9
Hardwood flooring, ⅞″ thick	4
Subflooring (soft wood), ¾″ thick	2½
Gypsum slab, per inch of thickness	6
CEILINGS:—	
¾″ plaster directly on concrete, blocks or tile	5
¾″ plaster on metal lath furring	8
¾″ plaster on metal lath and channel suspended ceiling construction	10
Plaster on rock lath and channel ceiling construction	6
Acoustical fiber tile directly on concrete blocks or tile	1

WEIGHTS OF FLOORS, CEILINGS, AND ROOFS, IN POUNDS PER SQUARE FOOT

	Weight (psf)
CEILINGS (Cont.):—	
Acoustical fiber tile on rock lath and channel ceiling construction	5
Acoustical fiber tile on suspended wood furring strips	3
ROOFS:—	
Five-ply felt and gravel (or slag)	6½
Three-ply felt and gravel (or slag)	5½
Five-ply felt composition roof, no gravel	4
Three-ply felt composition roof, no gravel	3
Asphalt strip shingles	3
Cement tile	16
Slate, ¼" thick	9½
Slate, ½" thick	19
Sheathing, ¾" thick, Yellow Pine	3½
Sheathing, ¾" thick, Spruce or Hemlock	2½
Skylight with galvanized iron frame, ¼" wire glass	7
Gypsum, per inch of thickness	4
Poured gypsum on steel rails, per inch of thickness	5
Light-weight fill or insulation, porous glass, vermiculite, etc., per inch of thickness	1 to 2
Light-weight fill or insulation, cinder concrete, per inch of thickness	8
Spanish tile (laid)	9 to 12
Shingle-type clay tile	12 to 14
Metal deck (20 gauge)	2¼
Metal deck (18 gauge)	3
Corrugated metal (20 gauge)	1½
Flat cement tile, per inch of thickness	13

WEIGHTS OF WALLS AND PARTITIONS; IN POUNDS PER SQUARE FOOT

	Weight (psf)		
	Un-plastered	One Side Plastered	Both Sides Plastered
WALLS:—			
4″ brick wall	40	45	50
9″ brick wall	80	85	90
13″ brick wall	120	125	130
17″ brick wall	160	165	170
21″ brick wall	205	210	215
25″ brick wall	245	250	255
4″ concrete block	28	33	38
6″ concrete block	36	41	46
8″ concrete block	51	56	61
12″ concrete block	59	64	69
4″ hollow light-weight block (tile or cinder)	19	24	29
6″ hollow light-weight block (tile or cinder)	22	27	32
8″ hollow light-weight block (tile or cinder)	33	38	43
12″ hollow light-weight block (tile or cinder)	44	49	54
4″ brick, 4″ hollow concrete block backing	68	73	—
4″ brick, 8″ hollow concrete block backing	91	96	—
4″ brick, 12″ hollow concrete block backing	119	124	—
4″ terra cotta tile	25	30	35
8″ terra cotta tile	33	38	43
12″ terra cotta tile	45	50	55
4″ glass block	20	—	—

WEIGHTS OF WALLS AND PARTITIONS, IN POUNDS PER SQUARE FOOT

	Weight (psf)		
	Unplastered	One Side Plastered	Both Sides Plastered
WALLS (Cont.):—			
Windows, glass, frame and sash	8	—	—
Porcelain enamel on sheet steel	3	—	—
Structural glass, per inch of thickness	15	—	—
4″ stone	55	—	—
Asbestos hardboard (corrugated), per ¼″ of thickness	3	—	—
4″ brickwork with 4″ hollow tile backing	60	65	—
4″ brickwork with 8″ hollow tile backing	75	80	—
PARTITIONS:—			
3″ clay tile	17	22	27
4″ clay tile	18	23	28
6″ clay tile	25	30	35
8″ clay tile	31	36	41
10″ clay tile	35	40	45
3″ gypsum block	10	15	20
4″ gypsum block	13	17	22
5″ gypsum block	16	19	24
6″ gypsum block	17	21	26
2″ solid plaster	—	—	20
2 x 4 studs, or metal studs, lath and ¾″ plaster	—	—	18
Steel partitions	4	—	—
½″ plaster on gypsum block or clay tile	—	4	8

LIVE LOADS FOR STORAGE WAREHOUSES

RECOMMENDED LIVE LOADS FOR STORAGE WAREHOUSES

U. S. DEPARTMENT OF COMMERCE, NATIONAL BUREAU OF STANDARDS

Material	Wt per Cu Ft of Space (lb)	Ht of Pile (ft)	Wt per Sq Ft of Floor (lb)	Recmd. Live Load (psf)
BUILDING MATERIALS				
Asbestos	50	6	300	
Bricks, Building	45	6	270	
Bricks, Fire Clay	75	6	450	
Cement, Natural	59	6	354	
Cement, Portland	72-105	6	432-630	300
Gypsum	50	6	300	to
Lime and plaster	53	5	265	400
Tiles	50	6	300	
Woods, Bulk	45	6	270	
DRUGS, PAINTS, OILS, ETC.				
Alum, pearl, in barrels	33	6	198	
Bleaching powder in hogsheads	31	3½	102	
Blue vitriol, in barrels	45	5	226	
Glycerine, in cases	52	6	312	
Linseed oil, in barrels	36	6	216	
Linseed oil, in iron drums	45	4	180	
Logwood extract, in boxes	70	5	350	
Rosin, in barrels	48	6	288	200
Shellac, Gum	38	6	228	to
Soaps	50	6	300	300
Soda ash, in hogsheads	62	2¾	167	
Soda, Caustic, in iron drums	88	3⅜	294	
Soda, Silicate, in barrels	53	6	318	

RECOMMENDED LIVE LOADS FOR STORAGE WAREHOUSES (Cont.)

Material	Wt per Cu Ft of Space (lb)	Ht of Pile (ft)	Wt per Sq Ft of Floor (lb)	Recmd. Live Load (psf)
DRUGS, PAINTS, OILS, ETC. (Cont.)				
Sulphuric acid	60	1 5/8	100	
Toilet articles	35	6	210	
Varnishes	55	6	330	
White lead paste, in cans	174	3 1/2	610	
White lead, dry	86	4 3/4	408	
Red lead and Litharge, dry	132	3 3/4	495	
DRY GOODS, COTTON, WOOL, ETC.				
Burlap, in bales	43	6	258	
Carpets and rugs	30	6	180	
Coir Yarn, in bales	33	8	264	
Cotton, in bales, American	30	8	240	
Cotton, in bales, Foreign	40	8	320	
Cotton bleached goods in cases	28	8	224	
Cotton Flannel, in cases	12	8	96	
Cotton Sheeting, in cases	23	8	184	
Cotton Yarn, in cases	25	8	200	
Excelsior, compressed	19	8	152	200
Hemp, Italian, compressed	22	8	176	to
Hemp, Manila, compressed	30	8	240	250
Jute, compressed	41	8	328	
Linen Damask, in cases	50	5	250	
Linen Goods, in cases	30	8	240	
Linen Towels, in cases	40	6	240	
Silk and Silk Goods	45	8	360	
Sisal, compressed	21	8	168	
Tow, compressed	29	8	232	

RECOMMENDED LIVE LOADS FOR STORAGE WAREHOUSES (Cont.)

Material	Wt per Cu Ft of Space (lb)	Ht of Pile (ft)	Wt per Sq Ft of Floor (lb)	Recmd. Live Load (psf)
DRY GOODS, COTTON, WOOL, ETC. (Cont.)				
Wool, in bales, compressed	48	8		
Wool, in bales, not compressed	13	8	104	
Wool, Worsteds, in cases	27	8	216	
GROCERIES, WINES, LIQUORS, ETC.				
Beans, in bags	40	8	320	
Beverages	40	8	320	
Canned Goods, in cases	58	6	348	
Cereals	45	8	360	
Cocoa	35	8	280	
Coffee, Roasted, in bags	33	8	264	
Coffee, Green, in bags	39	8	312	
Dates, in cases	55	6	330	
Figs, in cases	74	5	370	
Flour, in barrels	40	5	200	250
Fruits, Fresh	35	8	280	to
Meat and Meat Products	45	6	270	300
Milk, Condensed	50	6	300	
Molasses, in barrels	48	5	240	
Rice, in bags	58	6	348	
Sal Soda, in barrels	46	5	230	
Salt, in bags	70	5	350	
Soap Powder, in cases	38	8	304	
Starch, in barrels	25	6	150	
Sugar, in barrels	43	5	215	
Sugar, in cases	51	6	306	

RECOMMENDED LIVE LOADS FOR STORAGE WAREHOUSES (Cont.)

Material	Wt per Cu Ft of Space (lb)	Ht of Pile (ft)	Wt per Sq Ft of Floor (lb)	Recmd. Live Load (psf)
GROCERIES, WINES, LIQUORS, ETC. (Cont.)				
Tea, in chests	25	8	200	
Wines and Liquors, in barrels	38	6	228	
HARDWARE, ETC.				
Automobile Parts	40	8	320	
Chain	100	6	600	
Cutlery	45	8	360	
Door Checks	45	6	270	
Electrical Goods and Machinery	40	8	320	
Hinges	64	6	384	
Locks, in cases, packed	31	6	186	
Machinery, Light	20	8	160	
Plumbing, Fixtures	30	8	240	300
Plumbing, Supplies	55	6	330	to
Sash Fasteners	48	6	288	400
Screws	101	6	606	
Shafting Steel	125			
Sheet Tin, in boxes	278	2	556	
Tools, Small, Metal	75	6	450	
Wire, Insulated Copper, in coils	63	5	315	
Wire, Galvanized Iron, in coils	74	4½	333	
Wire, Magnet, on spools	75	6	450	

RECOMMENDED LIVE LOADS FOR STORAGE WAREHOUSES (Cont.)

Material	Wt per Cu Ft of Space (lb)	Ht of Pile (ft)	Wt per Sq Ft of Floor (lb)	Recmd. Live Load (psf)
MISCELLANEOUS				
Automobile tires	30	6	180	
Automobiles, uncrated	8		64	
Books (solidly packed)	65	6	390	
Furniture	20			
Glass and Chinaware, in crates	40	8	320	
Hides and Leather, in bales	20	8	160	300
Hides, Buffalo, in bundles	37	8	296	
Leather and Leather Goods	40	8	320	
Paper, Newspaper, and Strawboards	35	6	210	
Paper, Writing and Calendared	60	6	360	
Rope, in coils	32	6	192	
Rubber, crude	50	8	400	
Tobacco, bales	35	8	280	

STRUCTURAL LIVE LOADS

STRUCTURAL LIVE LOADS

UNIFORM LIVE LOADS IN POUNDS PER SQ. FT.

Occupancy or Use	Code	
	City of St. Louis 1945	B.O.C.A.* 1955
Alleys, Driveways, Yards and Terraces:		
Pedestrian	—	100
Vehicular	—	250
Armories and Drill Rooms	150	150
Assembly:		
Fixed Seats	75	60
Removable Seats (or none)	100	100
Balcony (Exterior)	100	100
Bowling Alleys, Pool Halls, and similar Recreational Areas	75	75
Class Rooms:		
Fixed Seats	50	60
Removable Seats	—	100
Cornices	—	75
Corridors:		
Hotels, Hospitals and Multi-Family Dwellings	75	60
One and Two Family Dwellings	40	40
serving Public Rooms in Hotels	75	100
Corridors and Entrance Hallways other than Residential Buildings	100	100

*B.O.C.A. — *Building Officials Conference of America*

STRUCTURAL LIVE LOADS

UNIFORM LIVE LOADS IN POUNDS PER SQ. FT.

Occupancy or Use	Code	
	City of St. Louis 1945	B.O.C.A.* 1955
Corridors (Other than those specifically designated):		
Private	Same as Occupancy Served	Same as Occupancy Served
Public — In Office Bldgs.	75	100
Court Rooms	(See Assembly)	100
Dance Halls and Gymnasiums	125	100
Dwellings:		
First Floor	40	40
Second Floor and Habitable Attic	40	30
Elevator Machine Rooms	—	100
Garages — Passenger Cars Only	75	75[a]
Garages — Busses and Trucks		
Columns, Beams and Girders	125	120[b]
Floor Slabs	125	175[b]
Grandstands, Reviewing Stands, and Bleachers (Stadia)	100	100
Hospitals:		
Operating Rooms	50	60
Private Rooms	50	40
Wards	50	40
Libraries:		
Reading Rooms	60	60
Stack Rooms	125	150[c]

**B.O.C.A. — Building Officials Conference of America*

STRUCTURAL LIVE LOADS

UNIFORM LIVE LOADS IN POUNDS PER SQ. FT.

Occupancy or Use	Code	
	City of St. Louis 1945	B.O.C.A.* 1955
Manufacturing:		
Heavy	Not Less Than Actual Loads	Not Less Than Actual Loads
Light	100	125
Marquees	—	75
Office Buildings:		
Lobbies	100	100
Rooms	50	50
Penal Institutions: Cell Blocks	—	40
Public Parking Structures, Passenger Cars Only:		
Parts of Floor Accessible to Wheel Loads	75	75
Parts of Floor Not Accessible to Wheel Loads	—	50
Restaurants and Public Dining Rooms	75	100
Sidewalks	300	250
Skating Rinks	100	75
Stairs, Fire Escapes and Exitways	100	100
Storage Warehouse:		
Heavy	Not Less Than Actual Loading	250
Light	150[d]	125

*B.O.C.A. — *Building Officials Conference of America*

STRUCTURAL LIVE LOADS

UNIFORM LIVE LOADS IN POUNDS PER SQ. FT.

Occupancy or Use	Code	
	City of St. Louis 1945	B.O.C.A.* 1955
Stores and Shops — Retail:		
Grade Floor	125	100
Upper Floors	100	75
Stores and Shops — Wholesale	125 1st Fl. 100 Above 1st	125
Theatres:		
Aisles, Corridors and Lobbies	100	100
Balconies	75	60
Orchestra Floors	75	60
Stage Floors	200	150
Roofs:		
Flat — Not Subject to Snow Load	—	20
Flat — Subject to Snow Load	30	30

**B.O.C.A.* — *Building Officials Conference of America*

a — Cars not exceeding 6000 lb. wt.
b — Busses and trucks not exceeding 20,000 lbs. wt.
c — Not less than actual weight of loaded shelves.
d — Not less than the actual loading.

B.O.C.A. CODE:

Floors of buildings shall be designed to support the uniformly distributed live loads or the follow-

B.O.C.A. CODE—(Continued):

ing concentrated loads, whichever produces the greater stress. Concentrated loads shall be assumed to occupy an area of two and one half ft. (2½) square feet (unless noted) and shall be so located as to produce maximum stress conditions in the structural members; except that in steel joist construction, properly bridged, the specified concentration shall be assumed as distributed over three (3) steel joists and each individual joist shall be capable of sustaining a concentrated load of eight hundred (800) pounds at the panel point.

CONCENTRATED LOADS

Location	Pounds
Elevator Machine Room Grating (on Area of 4 Sq. In.)	300
Finish Light Floor Plate Construction (on Area of 1 Sq. In.)	200
Garage, Pleasure Cars	2000
Garage, Trucks	150% Max. Wheel Ld.
Office Floors	2000
Scuttles and Skylight Ribs	200
Sidewalks	8000
Stair Treads (on Center of Tread)	300

**B.O.C.A. — Building Officials Conference of America*

A Manual of Useful Data

BASIC MECHANICS OF BUILDING MATERIALS

BASIC MECHANICS OF BUILDING MATERIALS

BASIC FORMULA

(*NOTE: For nomenclature not given see pages 33 and 34*).

EQUATIONS OF EQUILIBRIUM

$\Sigma Fx = 0$
$\Sigma Fy = 0$
$\Sigma Fz = 0$
ΣM (about any point) $= 0$
Σ = Sum of
F = Force
x, y, z = All directions

EQUATION FOR DIRECT STRESS

$$f = \frac{P}{A}$$

f = Direct unit stress
A = Area

EQUATION FOR MOMENT OF INERTIA

$I = Io + Ad^2$
I = Moment of inertia about any axis
Io = Moment of inertia about neutral axis
A = Area
d = Distance between any axis and the neutral axis

EQUATION FOR RADIUS OF GYRATION

$$r = \sqrt{\frac{I}{A}}$$

A = Area of member

EQUATION FOR SECTION MODULUS

$$S = \frac{I}{c} = \frac{M}{f}$$

f = Flexural unit stress

BASIC FORMULA (Cont.)

EQUATION FOR FLEXURAL STRESS IN EXTREME FIBER

$$f = \frac{Mc}{I} = \frac{M}{S}$$

f = Flexural unit stress

EQUATION FOR COMBINED DIRECT AND FLEXURAL STRESS

$$f = \frac{P}{A} \pm \frac{Mc}{I}$$

f = Combined unit stress

P = Total direct load

EQUATION FOR AVERAGE VERTICAL SHEAR

$$v = \frac{V}{A}$$

v = Unit shear

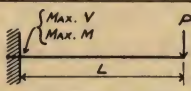
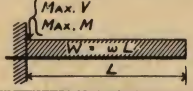
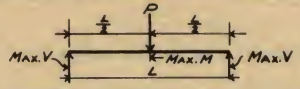
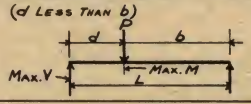
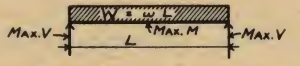
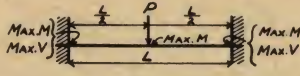
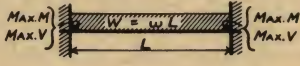
V = Total shear

EQUATION FOR HORIZONTAL SHEARING STRESS AT ANY SECTION (1-1)

$$v = \frac{VQ}{Ib}$$

Q = Statical moment about neutral axis of that portion of the cross section lying outside section (1-1)

b = Width of member at section (1-1)

Formula for Maximum Shear and Bending Moments of Beams			
Case	Method of Loading W = Total Load w = Load Per Ft. L = Span P = Conct. Ld.	Maximum Shear (V)	Maximum Moment (M)
1		P	PL
2		W	$\frac{WL}{2}$
3		$\frac{P}{2}$	$\frac{PL}{4}$
4		$\frac{Pb}{L}$	$\frac{Pab}{L}$
5		$\frac{W}{2}$	$\frac{WL}{8}$
6		$\frac{P}{2}$	$\frac{PL}{8}$
7		$\frac{W}{2}$	$\frac{WL}{12}$

BASIC MECHANICS OF BUILDING MATERIALS

DEFINITIONS AND NOMENCLATURE

LOAD (P or W)

Loads are usually indicated by vectors giving direction, magnitude and point of application of a force and may be considered concentrated (P) or uniform (W).

REACTION (R)

at any support of a member is equal to the total amount of load the member imparts to the support and is directed opposite to the imparted load.

SHEAR (V)

The total shear on the cross section of a member may be defined as the sum of all the forces acting to the right (or left) of the section.

MOMENT (M)

on the cross section of a simply supported member may be defined as the algebraic sum of the products of all the loads and reactions to the right (or left) of the section times the distances to their center of action.

NEUTRAL AXIS (N.A.)

The neutral axis of a member in bending is a line in the cross section of the member on which there is neither compression nor tension.

DISTANCE TO EXTREME FIBER (c)

The distance to the extreme fiber of a member is the normal distance from the neutral axis to the outermost part under consideration.

DEFINITIONS AND NOMENCLATURE (Cont.)

MOMENT OF INERTIA
is the sum of the products resulting from multiplying each of the elementary areas of the section by the square of its normal distance from the neutral axis of the section.

MAJOR AXIS
is the axis about which the moment of inertia of the section is greater.

MINOR AXIS
is the axis about which the moment of inertia of the section is smaller.

MODULUS OF ELASTICITY (E)
may be expressed as the unit stress required to exactly double the length of a perfectly elastic material.

RADIUS OF GYRATION (r)
is the normal distance from a neutral axis to the center of gyration — the point where the entire area is considered to be concentrated and to have the same moment of inertia as the actual area.

SECTION MODULUS (S)
is a more or less abstract quantity used in proportioning members for bending moment. It may be expressed as the ratio of moment of inertia (I) to distance to extreme fiber (c); or the ratio of the bending moment (M) to the fiber stress (f).

FLEXURAL STRESS IN EXTREME FIBER (f)
is the unit stress produced in the outmost fiber of a member by a bending moment on the section.

REINFORCING RODS

Reinforcing Rods for concrete should consist of deformed rods rolled from billet steel, structural, intermediate or hard grade; or deformed rods rerolled from steel rails or axles. The following standard sizes of rods are manufactured and none other should be used.

REINFORCING RODS
ASTM STANDARD A305 REINFORCING RODS

Rod Sizes		Weight Pounds Per Foot	Nominal Dimension Round Sections		
Old Size (Inches)	New Number		Diameter (Inches)	Area (Sq. Inches)	Perimeter (Inches)
¼ϕ	#2	.167	.250	.05	.786
⅜ϕ	#3	.376	.375	.11	1.178
½ϕ	#4	.668	.500	.20	1.571
⅝ϕ	#5	1.043	.625	.31	1.963
¾ϕ	#6	1.502	.750	.44	2.356
⅞ϕ	#7	2.044	.875	.60	2.749
1″ϕ	#8	2.670	1.000	.79	3.142
1″ sq.	#9	3.400	1.128	1.00	3.544
1⅛″ sq.	#10	4.303	1.270	1.27	3.990
1¼″ sq.	#11	5.313	1.410	1.56	4.430

NOTE: The new rod numbers are based on the nearest number of ⅛ inches included in the nominal diameter of the rod.

WIRE MESH

Welded Wire Fabric, often called Wire Mesh is frequently used as reinforcement for slabs. This fabric consists of a series of longitudinal and transverse cold drawn steel wires arranged at right angles to each other and electrically welded at all intersections. The following table includes welded wire fabrics of common styles and should be used where possible.

COMMON STYLES OF WELDED WIRE FABRIC

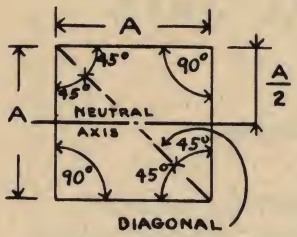
Style Designation Spa. x Spa. x Ga. x Ga.	Spacing of Wire (Inches)		Size of Wires A.S. & W Gage		Sectional Area Sq. In. Per Foot		Weight Lbs. Per 100 Sq. Ft.
	Longit.	Trans.	Longit.	Trans.	Longit.	Trans.	
4 x 4 — 4/4	4	4	4	4	.120	.120	85
4 x 4 — 6/6	4	4	6	6	.087	.087	62
4 x 4 — 8/8	4	4	8	8	.062	.062	44
6 x 6 — 4/4	6	6	4	4	.080	.080	58
6 x 6 — 6/6	6	6	6	6	.058	.058	42
6 x 6 — 8/8	6	6	8	8	.041	.041	30
6 x 6 — 10/10	6	6	10	10	.029	.029	21

MISCELLANEOUS USEFUL DATA

PLANE FIGURES
SOLIDS
BASIC PHYSICAL LAWS
FUNDAMENTAL MECHANICS
ALGEBRAIC EQUATIONS
GREEK ALPHABET

PLANE FIGURES

DEFINITION: A plane figure is a surface bounded by either straight or curved lines and having no thickness.



SQUARE

Diagonal for length see right triangle

Useful Formula

Perimeter $= 4A$

Area $= A^2$

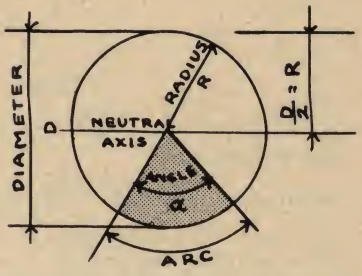
Mo. of Inertia $= \frac{A^4}{12}$

Section Modulus $= \frac{A^3}{6}$

Radius of Gyration $= \frac{A}{\sqrt{12}}$

PLANE FIGURES

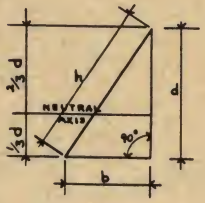
CIRCLE



Useful Formula

Pi (π)	$= 3.1416$
Circumference	$= \pi D$
Area	$= \frac{\pi D^2}{4} = \pi R^2$
Approx. Area	$= \frac{3}{4} D^2$
Length of Arc	$= \frac{\alpha}{360} \pi D$
Area of Sector (Hatched Area)	$= \frac{\alpha}{360} \pi R^2 = \frac{\text{Arc} \times R}{2}$
Mo. of Inertia	$= \frac{\pi R^4}{4}$
Section Modulus	$= \frac{\pi R^3}{4}$
Radius of Gyration	$= \frac{R}{2}$

PLANE FIGURES



RIGHT TRIANGLE

Useful Formula

Perimeter $= h+b+d$

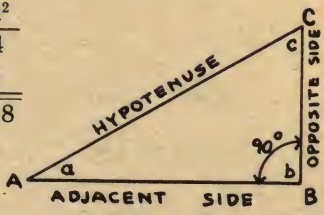
Given any two sides, the third side may be found from the following: $h^2=b^2+d^2$

Area $= \dfrac{bd}{2}$

Mo. of Inertia $= \dfrac{bd^3}{36}$

Section Modulus $= \dfrac{bd^2}{24}$

Radius of Gyration $= \dfrac{d}{\sqrt{18}}$



$90°+\text{Angle a}+\text{Angle c}=180°$

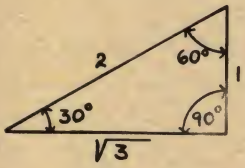
NOTE: Sides of triangle shown in sketch are for angle a.

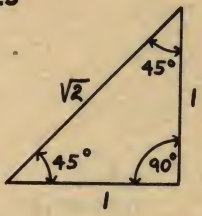
Sine a $= \dfrac{\text{Opposite Side (BC)}}{\text{Hypotenuse (AC)}}$

Cosine a $= \dfrac{\text{Adjacent Side (AB)}}{\text{Hypotenuse (AC)}}$

Tangent a $= \dfrac{\text{Opposite Side (BC)}}{\text{Adjacent Side (AB)}}$

PLANE FIGURES





COMMON RIGHT TRIANGLES

Useful Formula

Functions of angles in 30° and 60° triangle, and 45° triangle are as follows:

Sine 30° $= \frac{1}{2} = .50000$

Sine 45° $= \frac{1}{\sqrt{2}} = .70711$

Sine 60° $= \frac{\sqrt{3}}{2} = .86603$

Cosine 30° $= \frac{\sqrt{3}}{2} = .86603$

Cosine 45° $= \frac{1}{\sqrt{2}} = .70711$

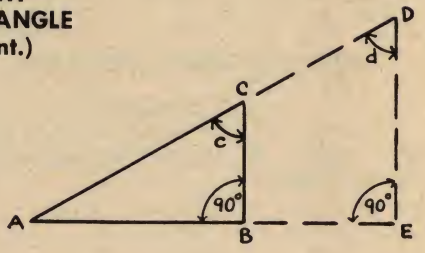
Cosine 60° $= \frac{1}{2} = .50000$

Tangent 30° $= \frac{1}{\sqrt{3}} = .57735$

Tangent 45° $= \frac{1}{1} = 1.0000$

Tangent 60° $= \frac{\sqrt{3}}{1} = 1.7321$

RIGHT TRIANGLE (Cont.)



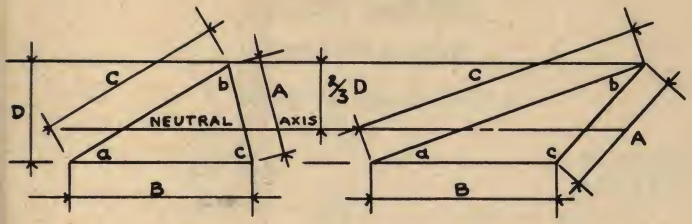
Useful Formula

Triangles ABC & AED are similar triangles

$$\frac{AC}{AD} = \frac{AB}{AE} = \frac{BC}{DE}$$

Angle c = Angle d

PLANE FIGURES



Acute Obtuse

ACUTE AND OBTUSE TRIANGLES

Useful Formula

Perimeter $= A+B+C$

Area $= \frac{BD}{2}$

Mo. of Inertia $= \frac{BD^3}{36}$

Section Modulus $= \frac{BD^2}{24}$

Radius of Gyration $= \frac{D}{\sqrt{18}}$

Angles $a+b+c = 180°$

$$\frac{\text{Sin } a}{A} = \frac{\text{Sin } b}{B} = \frac{\text{Sin } c}{C}$$

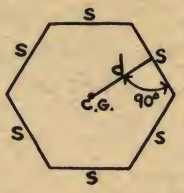
$A^2 = B^2+C^2-2BC \text{ Cos } a$

When all of the angles of one acute (or obtuse) triangle are equal to the angles of another acute (or obtuse) triangle then the triangles are similar and the sides are proportionate as shown above for right triangles.

PLANE FIGURES

MISCELLANEOUS

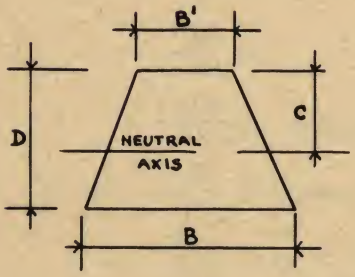
REGULAR POLYGON



5 sides or more all sides "S" equal.

Σ = ("Sum of")

$$\text{Area} = \Sigma\frac{S \times d}{2}$$



TRAPEZOID

Sides B & B^1 are parallel.

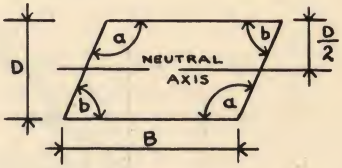
$$\text{Area} = \frac{D\ (B+B^1)}{2}$$

$$C = \frac{D\ (2B+B^1)}{3\ (B+B^1)}$$

PLANE FIGURES

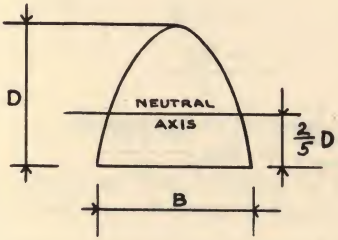
MISCELLANEOUS (Cont.)

PARALLELOGRAM



Opposite sides equal and parallel. Opposite angles equal.

$$\text{Area} = BD$$



PARABOLA

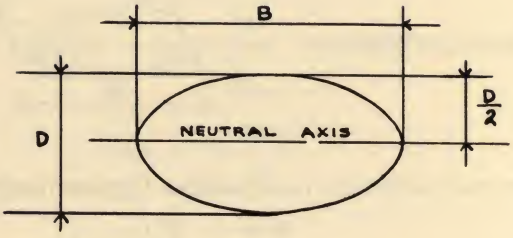
$$\text{Length of Arc (Approx.)} = 2\sqrt{\frac{B^2}{4}+\frac{4D^2}{3}}$$

$$\text{Area} = \frac{2}{3}DB$$

PLANE FIGURES

MISCELLANEOUS (Cont.)

ELLIPSE



$$\text{Pi } (\pi) = 3.1416$$

$$\text{Area} = \frac{\pi \, BD}{4}$$

$$\text{Perimeter (Approx.)} = 2\pi\sqrt{\frac{B^2+D^2}{8}}$$

IRREGULAR AREAS

Irregular areas may be found by dividing into a number of regular areas and summing up or by the use of Simpson's Rule given on the following page.

MISCELLANEOUS (Cont.)

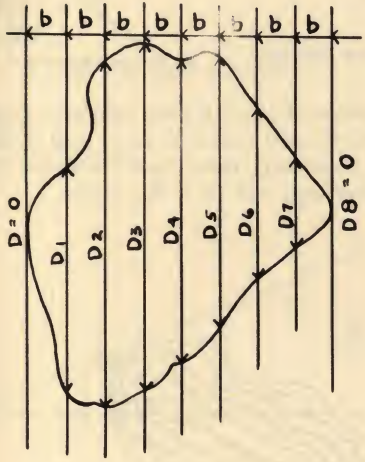


FIGURE
SIMPSON'S RULE

Simpson's Rule for Irregular Areas

Divide area into even number of panels by means of parallel lines spaced equal distance b apart.

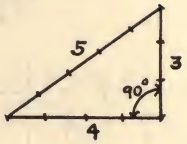
Then Area $= \frac{1}{3}b\,[(D+D8)+4(D1+D3+D5+D7)$
$+2(D2+D4+D6)]$

The greater the number of panels into which the irregular area is divided, the more accurate will be the solution.

PRACTICAL EXAMPLES OF USE OF DATA

Given —

6 ft. folding rule.



Find —

90° angle. (Square corner).

Solution —

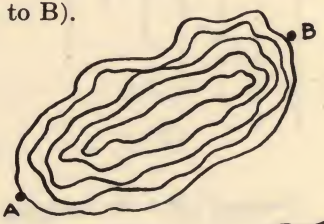
A 6 foot rule consists of 12 — 6 inch jointed pieces. If these are divided into units of 3, 4, and 5 and the ends joined together, the angle between the 3 piece and 4 piece legs will be a 90° angle.

Given —

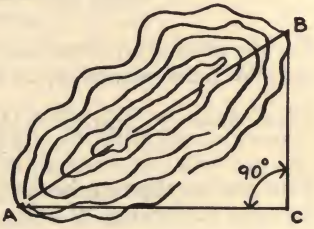
A pond.

Find —

Its length (A to B).



Solution —



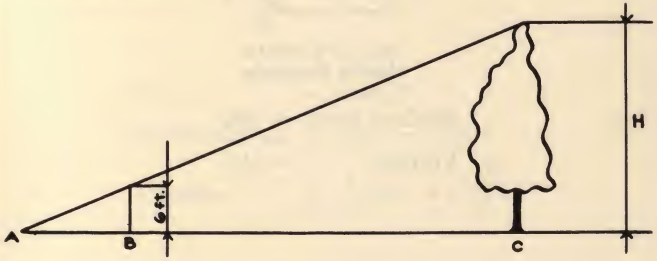
Measure BC perpendicular to AC.
Then AB $= \sqrt{(AC)^2 + (BC)^2}$

Given —

A tree too high to climb.

Find —

Its height.



Solution —

By sight find point A on ground where top of 6 ft. rule and top of tree are in line. Measure AB and AC.

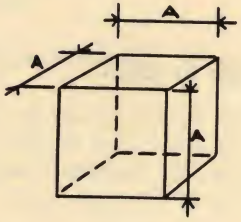
$$\text{Then} \frac{H}{AC} = \frac{6}{AB}$$

$$H = \frac{6\ AC}{AB}$$

SOLIDS

DEFINITION: A solid has length, width and thickness or depth.

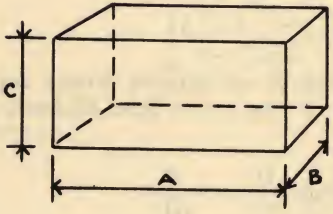
CUBE



Useful Formula

Surface Area $= 6A^2$

Volume $= A^3$



RECTANGULAR SOLID

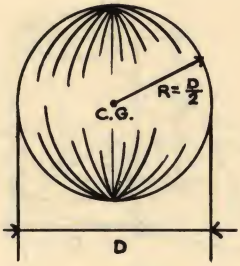
Useful Formula

Surface Area $= 2AC+2AB+2BC$

Volume $= A \times B \times C$

SOLIDS

SPHERE

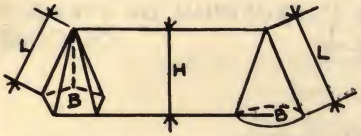


Useful Formula

$$\text{Pi } (\pi) = 3.1416$$

$$\text{Surface Area} = \pi D^2 = 4\pi R^2$$

$$\text{Volume} = \frac{4}{3}\pi R^3 = \frac{\pi D^3}{6}$$



PYRAMID OR CONE

Pyramid **Cone**

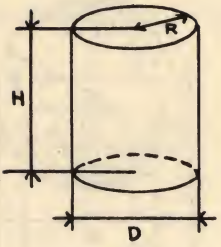
Useful Formula

$$\text{Surface Area} = \frac{\text{Perimeter of base} \times L}{2}$$

$$\text{Volume} = \frac{\text{Area of base (B)} \times H}{3}$$

SOLIDS

CYLINDER

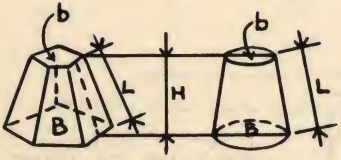


Useful Formula

$$\text{Pi } (\pi) = 3.1416$$

$$\text{Surface Area} = 2\pi R^2 + \pi DH$$

$$\text{Volume} = \pi R^2 H = \frac{\pi D^2 H}{4}$$



FRUSTRUM OF PYRAMID OR CONE

Pyramid **Cone**

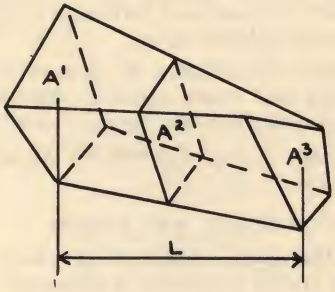
Useful Formula

B = Area Base P = Perimeter Base
b = Area Top p = Perimeter Top
L = Slant Height H = Perpendicular Height

$$\text{Surface Area} = \frac{(P+p)L}{2} + B + b$$

$$\text{Volume} = \frac{H}{3}\left(B + b + \sqrt{Bb}\right)$$

SOLIDS



IRREGULAR VOLUMES (PRISMOIDAL FORMULA)

Useful Formula

A^1 and A^3 = End areas
A^2 = Area at mid section
L = Perpendicular distance between parallel end areas

$$\text{Volume} = \frac{A^1+4A^2+A^3}{6} \times L$$

BASIC PHYSICAL LAWS

NEWTON'S LAWS OF MOTION

1. Every body continues in its state of rest or uniform motion and direction unless acted upon by some outside force.
2. Change of motion is proportional to force applied and takes place in the direction of the line of action of the force.
3. To every action there is an equal and opposite reaction.

HOOK'S LAW OF STRESS AND STRAIN

Within the elastic limit of any body the ratio of stress to strain produced is constant.

PASCAL'S LAW OF LIQUID PRESSURE

Pressure exerted at any point upon the mass of a liquid is transmitted undiminished in all directions.

ARCHIMEDE'S PRINCIPLE OF BUOYANCY AND DISPLACEMENT

A body wholly or partly immersed in a fluid is buoyed up by a force equal to the weight of the fluid displaced.

BOYLE'S LAW OF GAS PRESSURE AND VOLUME

For a perfect gas, changing from pressure P and volume V to pressure P′ and volume V′ without change of temperature $PV = P'V'$

OHM'S LAW OF ELECTRIC CURRENT

Current I (amperes) in terms of electromotive force E (volts) and resistance R (Ohms)

$$I = \frac{E}{R}$$

FUNDAMENTAL MECHANICS

Velocity

If S is the distance passed over in time T, the velocity $V = \frac{S}{T}$

Uniformly Accelerated Motion

If Vo is the initial velocity, Vt the velocity after time T, the acceleration a

$$a = \frac{Vt - Vo}{T}$$

$$Vt = Vo + aT$$

$$S = VoT + \tfrac{1}{2}aT^2$$

Falling Bodies

Symbols same as for uniformly accelerated motion except that Vo = O and g is the acceleration due to gravity = 32.2 Ft/sec^2.

$$Vt = gT$$

$$S = \tfrac{1}{2}gT^2$$

Momentum

$$\text{mass} = \frac{\text{weight}}{g} = m$$

A mass m moving with a velocity V has a momentum M.

$$M = mV$$

Force

For a mass m and an acceleration a, the force F

$$F = ma$$

Pressure

The unit pressure P due to a force F distributed over an area A

$$P = \frac{F}{A}$$

USEFUL ALGEBRAIC EQUATIONS

FACTORS AND EXPANSIONS

$$(A \pm B)^2 = A^2 \pm 2AB + B^2$$

$$(A \pm B)^3 = A^3 \pm 3A^2B + 3AB^2 \pm B^3$$

$$A^2 - B^2 = (A+B)\,(A-B)$$

$$(A+B)^n = A^n + {}_nA^{n-1}B + \frac{n(n-1)}{2!}A^{n-2}B^2 + \frac{n(n-1)(n-2)}{3!}A^{n-3}B^3 \ldots . B^n$$

QUADRATIC EQUATION

In any equation $ax^2 + bx + c = 0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

POWERS AND ROOTS

$$A^x \times A^y = A^{(x+y)} \qquad A^o = 1 \; [\text{IF } A \neq O]$$

$$\frac{A^x}{A^y} = A^{(x-y)} \qquad A^{-x} = \frac{1}{A^x}$$

$$(AB)^x = A^xB^x \qquad \left(\frac{A}{B}\right)^x = \frac{A^x}{B^x}$$

SUM OF NUMBERS

$$\text{Sum of (N) numbers} = 1+2+3+4 \ldots +N = \frac{N(N+1)}{2}$$

USEFUL ALGEBRAIC EQUATIONS (Cont.)

ARITHMETIC PROGRESSION

F = First term
D = Common difference
S = Sum of N terms

$$L = F+(N-1)D$$

L = Last term
N = Number of terms

$$S = \frac{N}{2}(F+L)$$

COMBINATIONS

(M) denotes the number of combinations of (N) things taken (P) at a time

! = Factorial e. g. $5! = 5\times4\times3\times2\times1$

$$M = \frac{N!}{P!(N-P)!}$$

INTEREST EQUATIONS

P = Principal
A = Amount
I = Interest rate-annual (Decimal)
$_n$ = Number of years

Simple Interest

$$A = P(1+{}_nI)$$

Compound Interest

$$A = P(1+I)^n$$

GREEK ALPHABET

GREEK LETTER		GREEK NAME	ENGLISH EQUIVALENT
Α	α	ALPHA	A
Β	β	BETA	B
Γ	γ	GAMMA	G
Δ	δ	DELTA	D
Ε	ϵ	EPSILON	E
Ζ	ζ	ZETA	Z
Η	η	ETA	E
Θ	θ	THETA	TH
Ι	ι	IOTA	I
Κ	κ	KAPPA	K
Λ	λ	LAMBDA	L
Μ	μ	MU	M
Ν	ν	NU	N
Ξ	ξ	XI	X
Ο	o	OMICRON	O
Π	π	PI	P
Ρ	ρ	RHO	R
Σ	σ	SIGMA	S
Τ	τ	TAU	T
Υ	υ	UPSILON	U
Φ	ϕ	PHI	PH
Χ	χ	CHI	CH
Ψ	ψ	PSI	PS
Ω	ω	OMEGA	O

WABASH DRILLED PILING

WABASH DRILLED PILING

DIAMETERS — AREAS CIRCUMFERENCES — VOLUMES — EQUIVALENTS					Bearing Capacity of Base at 5000#/o'	Friction Capacity Per Lin. Ft. of Shaft at 300#/o'
Diam-eter	Area	Circum-ference	Cube Per Lin. Ft.	Equivalent Square		
	Sq. Ft.	Ft.	Cu. Ft.		Kips	Kips
1'-0"	0.78	3.14	0.78	10⅝"×10⅝"	3.9	.94
1'-6"[1]	1.77	4.71	1.77	1'-4"×1'-4"	8.85	1.41
1'-9"	2.41	5.50	2.41	1'-7"×1'-7"	12.0	1.65
2'-0"[1]	3.14	6.28	3.14	1'-9"×1'-9"	15.7	1.94
2'-3"	3.96	7.07	3.96	2'-0"×2'-0"	19.8	2.12
2'-6"[1]	4.90	7.85	4.90	2'-3"×2'-3"	24.5	2.35
2'-9"	5.94	8.64	5.94	2'-5"×2'-5"	29.7	2.39
3'-0"[2]	7.07	9.42	7.07	2'-8"×2'-8"	35.3	2.83
3'-3"	8.31	10.21	8.31	2'-11"×2'-11"	41.5	
3'-6"	9.61	11.00	9.61	3'-1"×3'-1"	48.0	
3'-9"	11.09	11.78	11.09	3'-4"×3'-4"	55.4	
4'-0"[3]	12.57	12.57	12.57	3'-6"×3'-6"	62.8	
4'-3"	14.16	13.35	14.16	3'-9"×3'-9"	70.8	
4'-6"	15.90	14.14	15.90	4'-0"×4'-0"	79.5	
4'-9"	17.72	14.92	17.72	4'-2"×4'-2"	88.6	
5'-0"[4]	19.64	15.71	19.64	4'-5"×4'-5"	98.2	
5'-3"	21.65	16.49	21.65	4'-8"×4'-8"	108.2	
5'-6"	23.75	17.28	23.75	4'-10"×4'-10"	118.7	
5'-9"	25.95	18.06	25.95	5'-1"×5'-1"	129.7	
6'-0"	28.27	18.85	28.27	5'-4"×5'-4"	141.3	
6'-3"	30.66	19.64	30.66	5'-6"×5'-6"	153.3	
6'-6"	33.18	20.42	33.18	5'-9"×5'-9"	165.9	
6'-9"	35.78	21.21	35.78	6'-0"×6'-0"	178.9	
7'-0"[5]	38.48	21.99	38.48	6'-2"×6'-2"	192.4	
7'-3"	41.28	22.78	41.28	6'-5"×6'-5"	206.4	
7'-6"	44.17	23.56	44.17	6'-8"×6'-8"	220.8	
7'-9"	47.16	24.35	47.16	6'-10"×6'-10"	235.8	
8'-0"	50.27	25.13	50.27	7'-1"×7'-1"	251.3	

[1] 1'-6", 2'-0" & 2'-6" dia. are the most common shaft diameters for friction and machine belled piling.

[2] 3'-0" dia. is the most common shaft diameter for caissons and hand belled piling.

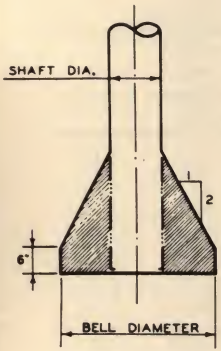
[3] 4'-0" dia. is the max. machine belled diameter with 18" dia. shaft.

[4] 5'-0" dia. is the max. machine belled diameter with 24" dia. shafts.

[5] 7'-0" dia. is the max. shaft diameter available (California Rig).

WABASH DRILLED PILING

VOLUME OF HAND CUT BELLS



Bell Diameter	30" Dia. Shaft	36" Dia. Shaft	42" Dia. Shaft
	Volume of Flange (Cubic Ft.)		
2'-6"			
2'-9"	0.5		
3'-0"	1.5		
3'-3"	3.0	1.0	
3'-6"	4.5	2.5	
3'-9"	7.0	3.5	1.0
4'-0"	9.0	5.5	2.5
4'-3"	12.5	8.0	4.0
4'-6"	15.5	10.5	6.0
4'-9"	19.5	14.0	9.0
5'-0"	24.0	18.0	11.5
5'-3"	29.0	22.5	16.0
5'-6"	34.0	27.0	20.0
5'-9"	40.5	33.0	25.5
6'-0"	47.5	39.0	30.5
6'-3"	54.5	46.0	37.0
6'-6"	62.5	53.5	44.0
6'-9"	71.5	61.5	51.5
7'-0"	81.0	71.5	59.5
7'-3"	91.0	80.0	68.5
7'-6"	102.0	91.0	78.5
7'-9"	119.5	102.0	89.5
8'-0"	125.5	113.5	100.5

NOTE: The volume of the shaded portions is the volume shown to the right.

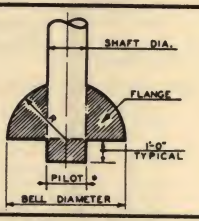
Hand excavated undercuts in excess of 1'-6" (Bell Dia. 3'-0" more than shaft dia.) require extremely stable soil.

Soil thruout depth of shaft and bell must be dimensionally stable (non-caving) or the hole must be cased to well below the unstable strata.

WABASH DRILLED PILING

VOLUME OF MACHINE CUT BELLS

NOTE: The volume of the shaded portions in the volume shown below. *For 18", 24", 30" and 36" shafts the pilot diameter is the same as the shaft diameter. For 42" and larger shafts the pilot diameter is 36".



Bell Diameter	18" Dia. Shaft	24" Dia. Shaft	30" Dia. Shaft	36" Dia. Shaft	42" Dia. Shaft	Bell Diameter
	Volume of Flange and Pilot (Cubic Ft.)					
1'-6"						1'-6"
1'-9"	2.0					1'-9"
2'-0"	2.5					2'-0"
2'-3"	3.0	3.5				2'-3"
2'-6"	4.0	4.0				2'-6"
2'-9"	5.0	5.0	5.5			2'-9"
3'-0"	6.5	6.0	6.0			3'-0"
3'-3"	8.0	7.5	7.5	7.5		3'-3"
3'-6"	10.0	9.5	9.0	8.5		3'-6"
3'-9"	12.5	11.5	10.5	10.0	7.5	3'-9"
4'-0"	15.0	14.0	13.0	12.0	9.0	4'-0"
4'-3"		17.0	15.5	14.0	11.0	4'-3"
4'-6"		20.5	18.5	17.0	13.0	4'-6"
4'-9"		24.0	22.0	20.0	15.5	4'-9"
5'-0"		28.5	26.0	24.0	19.0	5'-0"
5'-3"			30.5	28.0	23.0	5'-3"
5'-6"			35.5	32.5	27.0	5'-6"
5'-9"			41.0	38.0	32.0	5'-9"
6'-0"			47.5	43.5	37.5	6'-0"
6'-3"			54.0	50.5	43.5	6'-3"
6'-6"			61.5	57.5	50.0	6'-6"
6'-9"			69.5	65.0	57.5	6'-9"
7'-0"			78.0	73.0	65.5	7'-0"

Machine cut bells require extension into firm original soil so that top of bell is 1'-0" (min.) into stable soil.

Soil thruout depth of shaft and bell must be dimensionally stable (non-caving) or the hole must be cased to well below the unstable strata.

The largest diameter listed is the maximum size available with present equipment.

WABASH DRILLED PILING

SAFE SUPERIMPOSED LOADS FOR FRICTION PILES

FRICTION CAPACITY at 200 psf. (Soft Silt and Dense Muck)

Length of Pier	18″ Pier 4.71′ Cir	24″ Pier 6.28′ Cir	30″ Pier 7.85′ Cir
	Kips	Kips	Kips
6′-0″	5.6	7.5	9.4
7′-0″	6.6	8.8	11.0
8′-0″	7.5	10.0	12.6
9′-0″	8.5	11.3	14.1
10′-0″	9.4	12.6	15.7
11′-0″	10.4	13.8	17.3
12′-0″	11.3	15.1	18.8
13′-0″	12.2	16.3	20.4
14′-0″	13.2	17.6	22.0
15′-0″	14.1	18.8	23.6
16′-0″	15.1	20.1	25.1
17′-0″	16.0	21.4	26.7
18′-0″	16.9	22.6	28.3
19′-0″	17.9	23.0	29.8
20′-0″	18.8	25.1	31.4
21′-0″	19.8	26.4	33.0
22′-0″	20.7	27.6	34.5
23′-0″	21.7	28.9	36.1
24′-0″	22.6	30.1	37.7

WABASH DRILLED PILING

SAFE SUPERIMPOSED LOADS FOR FRICTION PILES

FRICTION CAPACITY at 250 psf. (Firm Silt, Wet But Confined)

Length of Pier	18″ Pier 4.71′ Cir	24″ Pier 6.28′ Cir	30″ Pier 7.85′ Cir
	Kips	Kips	Kips
6′-0″	7.1	9.4	11.8
7′-0″	8.2	11.0	13.7
8′-0″	9.4	12.6	15.7
9′-0″	10.6	14.1	17.7
10′-0″	11.8	15.7	19.6
11′-0″	13.0	17.3	21.6
12′-0″	14.1	18.8	23.6
13′-0″	15.3	20.4	25.5
14′-0″	16.5	22.0	27.5
15′-0″	17.7	23.6	29.4
16′-0″	18.8	25.1	31.4
17′-0″	20.0	26.7	33.4
18′-0″	21.2	28.3	35.3
19′-0″	22.4	29.8	37.3
20′-0″	23.6	31.4	39.3
21′-0″	24.7	33.0	41.2
22′-0″	25.9	34.5	43.2
23′-0″	27.1	36.1	45.1
24′-0″	28.3	37.7	47.1

WABASH DRILLED PILING

SAFE SUPERIMPOSED LOADS FOR FRICTION PILES

FRICTION CAPACITY at 300 psf. (Soft to Firm Clays)

Length of Pier	18″ Pier 4.71′ Cir	24″ Pier 6.28′ Cir	30″ Pier 7.85′ Cir
	Kips	Kips	Kips
6′-0″	8.5	11.3	14.1
7′-0″	9.9	13.2	16.5
8′-0″	11.3	15.1	18.8
9′-0″	12.7	16.9	21.2
10′-0″	14.1	18.8	23.6
11′-0″	15.5	20.7	25.9
12′-0″	17.0	22.6	28.3
13′-0″	18.4	24.5	30.6
14′-0″	19.8	26.4	33.0
15′-0″	21.2	28.3	35.3
16′-0″	22.6	30.1	37.7
17′-0″	24.0	32.0	40.0
18′-0″	25.4	33.9	42.4
19′-0″	26.8	35.8	44.7
20′-0″	28.3	37.7	47.1
21′-0″	29.7	39.6	49.5
22′-0″	31.1	41.4	51.8
23′-0″	32.5	43.3	54.2
24′-0″	33.9	45.2	56.5

WABASH DRILLED PILING

SAFE SUPERIMPOSED LOADS FOR FRICTION PILES

FRICTION CAPACITY at 350 psf. (Stiff Clays)

Length of Pier	18″ Pier 4.71′ Cir	24″ Pier 6.28′ Cir	30″ Pier 7.85′ Cir
	Kips	Kips	Kips
6′-0″	9.9	13.2	16.5
7′-0″	11.5	15.4	19.2
8′-0″	13.2	17.6	22.0
9′-0″	14.8	19.8	24.7
10′-0″	16.5	22.0	27.5
11′-0″	18.1	24.2	30.2
12′-0″	19.8	26.4	33.0
13′-0″	21.4	28.6	35.7
14′-0″	23.1	30.8	38.5
15′-0″	24.7	33.0	41.2
16′-0″	26.4	35.2	44.0
17′-0″	28.0	37.4	46.7
18′-0″	29.7	39.6	49.5
19′-0″	31.3	41.8	52.2
20′-0″	33.0	44.0	55.0
21′-0″	34.6	46.2	57.7
22′-0″	36.3	48.4	60.4
23′-0″	37.9	50.6	63.2
24′-0″	39.6	52.8	65.9

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WABASH DRILLING COMPANY
St. Louis 30, Missouri